Remarks/Arguments

This Amendment is in response to the Non-Final Official Action of the Examiner mailed September 25, 2003, setting a three-month shortened statutory period for response ending December 25, 2003. Claims 1-21, 24, 25, 27-29, 31 and 45-49 remain pending. Claims 24, 25, 27-29, 31 and 45-49 are allowed, and claims 1-21 stand rejected.

In paragraph 3 of the Office Action, the Examiner rejected claims 1-13 and 18-21 under 35 U.S.C. 102(b) as being anticipated by Cox et al. (WO 98/57402). The Examiner states that Figures 3 and 7 of Cox et al. illustrate a cladding or buffer layer having a sufficiently low refractive index to the refractive index of the waveguide. The Examiner also cited to pages 6-7, which discloses that Figures 3 and 7 are to be used in the optoelectronic device of Figures 5 and 6, respectively.

After careful review, Applicants must respectfully disagree. The reference cited by the Examiner, namely WO 98/57402 to Cox et al., corresponds to U.S. Patent Application Serial No. 08/872,534 to Cox et al., now U.S. Patent No. 6,055,262. Both WO 98/57402 and the present application have the same inventors, namely James A. Cox and Robert A. Morgan. In discussing their prior work in U.S. Patent Application Serial No. 08/872,534 to Cox et al., the present specification states:

> For many optoelectronic devices that have a resonant cavity, the top and/or bottom mirror stacks are Distributed Bragg Reflector (DBR) mirrors. DBR mirrors typically include a number of alternating layers of semiconductor material such as AlGaAs and AlAs. Often, both the top and bottom mirror stacks include a significant number of DBR mirror periods to achieve the desired reflectance. One way to reduce the number of DBR mirror periods that are required is to replace some of the DBR mirror periods with a resonant reflector. Such a configuration is disclosed in U.S. Patent Application Serial No. 08/872,534, entitled "Resonant

> Reflector For Improved Optoelectronic Device Performance And Enhanced Applicability", which is incorporated herein by reference. A typical resonant reflector may include, among other things, a waveguide and a grating.
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> Despite the advantages of using a resonant reflector in conjunction with a DBR mirror stack, it has been found that the reflectivity of the resonant reflector can be limited if it is not properly isolated from adjacent conductive layers. Too much energy in the guided-mode in the waveguide overlaps into the lossy, conductive DBR films of the optoelectronic device. What would be desirable, therefore, is an optoelectronic device that provides isolation between the resonant reflector and adjacent conducting layers of the optoelectronic device.

(Emphasis Added)(Specification, page 3, lines 3-20). As can readily be seen, the present invention is an improvement of the invention(s) disclosed in WO 98/57402 to Cox et al.

More specifically, WO 98/57402 to Cox et al. suggests using a resonant reflector (e.g. a waveguide and a grating) in conjunction with one or more of the mirrors of an optoelectronic device such as a VCSEL or RCPD. WO 98/57402 to Cox et al. does not, however, recognize or suggest that the reflectivity of the resonant reflector can become limited if it is not properly isolated from adjacent conductive layers, such as the conductive DBR layers of a VCSEL or RCPD. Unlike 98/57402 to Cox et al., the present recognizes that too much energy in the guided-mode in the waveguide may overlap into the lossy conductive DBR films of the optoelectronic device. To help overcome this, and in one illustrative embodiment, the present specification discloses providing a cladding or buffer layer between the resonant reflector and the selected mirror. The cladding or buffer layer is made sufficiently thick, and/or has a sufficiently low refractive index relative to the refractive index of the waveguide, to substantially prevent energy in the evanescent tail of the guided mode in the waveguide from entering the selected mirror.

Consistent therewith, claim 1 of the present specification recites:

1. (Currently Amended) An optoelectronic device having a top mirror and a bottom mirror, the top mirror and bottom mirror being at least partially conductive, the improvement comprising:

a resonant reflector positioned adjacent a selected one of the top or bottom mirrors, the resonant reflector having a waveguide and a grating configured such that a first-diffraction order wave vector of the grating substantially matches a propagating mode of the waveguide; and

a cladding or buffer layer positioned between the resonant reflector and the selected top or bottom mirror, the cladding or buffer layer being sufficiently thick, and/or having a sufficiently low refractive index relative to the refractive index of the waveguide, to substantially prevent energy in the evanescent tail of the guided mode in the waveguide from entering the selected top or bottom mirror.

Nowhere does WO 98/57402 to Cox et al. disclose or suggest providing a cladding or buffer layer between the resonant reflector and the selected top or bottom mirror, wherein the cladding or buffer layer is sufficiently thick, and/or having a sufficiently low refractive index relative to the refractive index of the waveguide, to substantially prevent energy in the evanescent tail of the guided mode in the waveguide from entering the selected top or bottom mirror. In view of the foregoing, claim 1 is believed to be clearly patentable over WO 98/57402 to Cox et al. If the Examiner elects to maintain the rejection of claim 1, Applicants respectfully request that the Examiner specifically point out where in WO 98/57402 to Cox et al. each and every limitation of claim 1 is disclosed or suggested, including those highlighted above. For similar reasons to those given above, as well as other reasons, independent claim 18, and dependent claims 2-13 and 19-21 are also believed to be clearly patentable over WO 98/57402 to Cox et al.

In paragraph 4 of the Office Action, the Examiner rejected claims 14-17 under 35 U.S.C. 102(b) as being anticipated by Alferness et al. (U.S. Patent No. 4,904,045). Although Applicants respectfully disagree with the Examiner's rejection, claim 14 has been amended to recite:

14. (Currently Amended) A Vertical Cavity Surface Emitting Laser (VCSEL) or Resonant Cavity Photo Detector (RCPD), ~~A resonant reflector for an optoelectronic device~~ comprising:

a top mirror and a bottom mirror, with an active region therebetween;

a resonant reflector positioned adjacent at least one of the top mirror and/or bottom mirror, the resonant reflector including:

a waveguide; and

a grating film having two or more spaced grating regions separated by one or more spaced regions, the spaced regions of the grating film having a grating film thickness that is less than the grating film thickness of the grating regions, but greater than ~~the~~ zero.

As can be seen, claim 14 now recites a Vertical Cavity Surface Emitting Laser (VCSEL) or Resonant Cavity Photo Detector (RCPD) that includes a top mirror and a bottom mirror, with an active region therebetween. Claim 14 further recites a resonant reflector positioned adjacent at least one of the top mirror and/or bottom mirror, wherein the resonant reflector includes a waveguide and a grating film. Finally, claim 14 recites that the grating film has two or more spaced grating regions separated by one or more spaced regions, the spaced regions of the grating film having a grating film thickness that is less than the grating film thickness of the grating regions, but greater than zero.

In contrast to claim 14, Alferness et al. appears to relate to edge emitting devices, where the grating functions to, for example, couple a mode propagating in one planar waveguide into a mode of a second waveguide. While it is a bit difficult to identify the specific elements in the Figures of Alferness et al. because of the lack of reference numerals in the description, Figure 3 of Alferness et al. appears to show an output window (labeled 304) that is located at the edge of the device, thus indicating an edge emitting device. This appears to be confirmed in the other drawings. For example, Figure 8 of Alferness et al. appears to shows incoming light 802 and

outgoing light 804 at the edge of the device. Likewise, Figure 9 of Alferness et al. appears to show incoming light 902 and outgoing light 904 at the edge of the device. Figure 10 of Alferness et al. appears to show incoming light 102 and outgoing light 110 at the edges of the device. Figure 11b of Alferness et al. appears to show incoming light 1108 and outgoing light 1106 at the edge of the device. Figure 11c of Alferness et al. appears to show incoming light 1126 and outgoing light 1124 at the edge of the device. Finally, Figure 11d of Alferness et al. appears to show incoming light 1152 and outgoing light 1154 at the edges of the device. Thus, the light of Alferness et al. clearly propagates in the horizontal direction along the planar waveguides, and not in the direction perpendicular to the plane of the waveguide, as in a VCSEL and RCPD devices. Moreover, there does not appear to be any resonance between the combined grating/waveguide structure.

Thus, Alferness et al. appears to relate to an edge emitting device, where the grating functions to, for example, couple a mode propagating in one planar waveguide into a mode of a second waveguide. This, however, in no way suggests using a resonant reflector in conjunction with a mirror of a VCSEL or RCPD, as recited in claim 14. In view thereof, claim 14 is believed to be clearly patentable over Alferness et al. For similar as well as other reasons, dependent claims 15-17 are also believed to be clearly patentable over Alferness et al.

In paragraph 5 of the Office Action, the Examiner rejected claims 14-17 under 35 U.S.C. 102(b) as being anticipated by Congdon et al. (U.S. Patent No. 5,673,284). After careful review, Applicants must respectfully disagree. Congdon et al. appear to suggest using a grating to couple light from an in-plane edge emitting laser into a dielectric waveguide (see Congdon et al.,

Abstract; Figure 2b and Figure 4a), similar to that discussed above with respect to Alferness et al. Thus, Congdon et al. appears to be another application of a grating coupler for two planar waveguides (the semiconductor waveguide of the edge emitting laser and the dielectric waveguide). Like Alferness et al., however, this in no way suggests using a resonant reflector in conjunction with a mirror of a VCSEL or RCPD, as recited in claim 14. In view thereof, claim 14 is believed to be clearly patentable over Congdon et al. For similar as well as other reasons, dependent claims 15-17 are also believed to be clearly patentable over Congdon et al.

In paragraph 6 of the Office Action, the Examiner indicated that claims 24-25, 27-29, 31 and 45-49 are allowed.

In view of the foregoing, Applicants believe all pending claims are now in condition for allowance. Reexamination and reconsideration to that end are respectfully requested. If the Examiner would like to discuss this Application or its examination in any way, please call the undersigned attorney at (612) 677-9050.

Respectfully submitted,

James Allen Cox et al.

By their attorney,

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Brian N. Tufte, Reg. No. 38,638
CROMPTON, SEAGER & TUFTE, LLC
1221 Nicollet Avenue, Suite 800
Minneapolis, MN 55403-2402
Telephone: (612) 677-9050
Facsimile: (612) 359-9349